

Can forest staff assist in biodiversity monitoring? A case study of Hornbill monitoring in Periyar Tiger Reserve, southern Western Ghats, India

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Abstract

A hornbill survey was conducted in Periyar Tiger Reserve, Kerala, India (*henceforth*, PTR), in February 2017, to assess their abundance and distribution. The frontline staff of PTR conducted the survey, after they were appropriately trained. The survey included trail and line transect counts in all the identified blocks of PTR. A trail count was used to estimate relative abundance, while a line transect count was used to estimate density. 208 hornbills were recorded during the trail survey and 104 along the transects. The encounter rate for the Great Hornbill (0.48 birds/km) was higher than that for the Malabar Grey Hornbill (0.29 birds/km), and there was a difference in the encounter rates of hornbills across forest sections. However, the density of the Malabar Grey Hornbill (8.2/sq. km.) was higher than the Great Hornbill (6.4/sq. km.). Hornbill detections varied significantly across forest types and elevation gradients.

The Western Ghats range, along the western coast of India, is recognised as one of the eight 'hotspots' of biological diversity in the world (Myers *et al.* 2000; Mittermeier *et al.* 2004). The region is also ecologically important because of its diverse floristic and faunistic composition, including the presence of a number of endemic species. The area also provides habitat for four of the nine species of hornbills recorded in India: Great *Buceros bicornis* [40], Malabar Grey *Ocyrceros griseus* [41], Indian

Grey *O. birostris*, and Malabar Pied *Anthroceros coronatus* (Kemp 1993; Grimmer *et al.* 2011). Of these, the Malabar Grey Hornbill is endemic to the region. The Great Hornbill is found both, in the Western Ghats, and in north-eastern India. The Malabar Pied Hornbill is found in central and southern India, and Sri Lanka. These large-bodied, wide-ranging frugivorous birds are considered flagship species, and play a major role in the dispersal of plant species. Their dependence on tall, dense, canopy-covered forest makes them vulnerable to habitat loss. They are also hunted in some parts of their range for their meat, feathers, and casque. The larger hornbill species are, hence, under rare and threatened category (IUCN 2016), and are under Schedule I of the Indian Wildlife Protection Act.

Kannan (1994), Kannan & James (1997, 1999), Mudappa & Kannan (1997), Datta & Rawat (2003, 2004), and Balasubramanian *et al.* (2004) have reported breeding, nest selection, and feeding of the hornbills in different parts of their range. Balasubramanian *et al.* (2004, 2007) recorded hornbill distribution in a number of sites in Kerala, Tamil Nadu, Karnataka, and Goa in the Western Ghats, as well as in parts of the Eastern Ghats. Mudappa & Raman (2009), based on a landscape level survey, identified five important hornbill conservation landscapes in the Western Ghats. Periyar is one of the identified landscapes, especially for Great and Malabar Grey Hornbills. However, Mudappa & Raman (2009) could cover only a small fraction of the area in Periyar and their observations were from two transects totalling 2.68 km, on which they spent 120 min.

Great Hornbill and Malabar Grey Hornbill have been recorded in PTR (Robertson & Jackson 1992; David *et al.* 2017). There are multiple sight reports of the Malabar Pied Hornbill (Veeramani &





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41. Malabar Grey Hornbill.

Krishnan 2002; Sashikumar *et al.* 2011; Srinivasan 2018) from within PTR, but none of them are accompanied by photographs or supporting field notes. Apart from this, there is a single report of the Indian Grey Hornbill (David *et al.* 2017), also from the park, but with no evidence to back the claim. In spite of the abundance of these two species, and PTR having been identified as an important hornbill conservation landscape, there is only one study on the hornbills of the park (Harikumar *et al.* 2001). That study provided glimpses into the nesting of the Great Hornbill and recommended preserving old growth forest to protect the species. The present study was carried out in February 2017 to gather information on the status and distribution of hornbills in PTR, using trained forest staff from the reserve.

Study area

Periyar Tiger Reserve is situated in the Cardamom- and Pandalam Hills of the southern Western Ghats, between 9.29°N and 9.61°N, and 76.93°E and 77.41°E (Fig. 1). The 925 sq. km. area has a buffer zone of 44 sq. km. and a core area of 881 sq. km. The reserve has a reservoir of 25 sq. km., formed by the Mullaperiyar Dam. The altitude of the reserve varies from 200 m asl in Pamba (in the west) to 2019 m asl at Kotamala (in the east). Rainfall is highly variable across the tiger reserve. The average annual rainfall is 2500 mm. A major share of the rainfall is received during the south-west monsoon. The average temperature varies between 11°C and 27°C. Tropical wet evergreen, and moist deciduous forests dominate the landscape.

Methods

Relative abundance

The entire PTR was divided into 59 blocks by the forest department for recording carnivore signs during the tiger monitoring exercise. The area of a block varies from 7.32 sq. km (Mavadi section, in Periyar Range) to 36.63 sq. km (Nellikampatty block, in Thekkady Range). One or more blocks constitute a section. As these blocks already represent various habitat types and elevation, the same blocks were used for our hornbill survey. The survey was carried out by frontline forest staff of Periyar Tiger Reserve in all the blocks. A training programme was conducted on 10

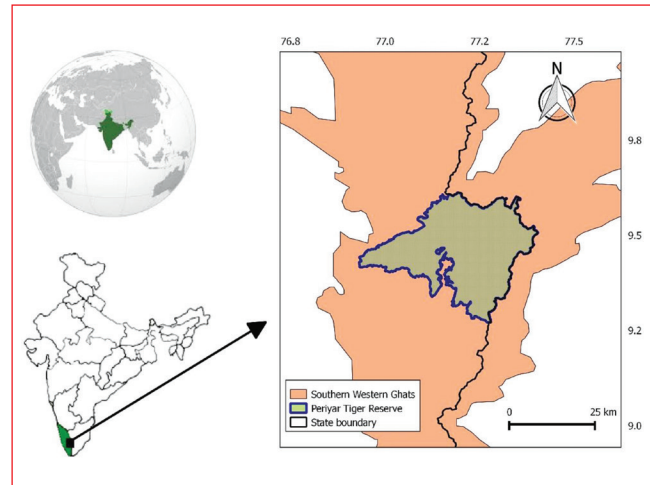


Fig. 1. Location of Periyar Tiger Reserve.

and 14 February 2017 on methods of field data collection, and identification keys for the species were distributed and explained [42]. This training programme equipped the forest staff to identify both the species correctly. The actual survey was conducted on 16 and 17 February 2017, simultaneously across all the blocks of the reserve. The trained forest staff walked a minimum of four kilometers, choosing a specific forest trail in each block, on the first day, recording hornbill numbers, and distance walked (using GPS and Periyar Tracks mobile application). Both, visual, and auditory cues were used to detect hornbills. The data collected were used for estimating the abundance as number of hornbills encountered per kilometer (encounter rate). As the survey was the first of its kind for hornbills, it was designed to obtain preliminary information on the distribution and relative abundance of the two hornbill species, as well as the efficacy of employing frontline forest staff to monitor large and prominent species like hornbills.



42. Training session of frontline forest staff of Periyar Tiger Reserve.

Density

Each block in PTR has a two kilometer long line transect. These transects cover all habitat types and elevation of the reserve and are not located along existing trekking paths. These transects were walked on the second day and all hornbills encountered were recorded along with the visually estimated perpendicular distance from the transect line to the hornbill. The data were used for density estimation using the Distance 6.0 software.

Table 1. Summary of hornbill encounter rates across forest sections

Section	Distance walked (km)	Encounter rate (No/km)	
		Great Hornbill	Malabar Grey Hornbill
Thekkady			
Mullakudy	9.5	0.42	1.25
Thekkady	5	0.60	0.60
Medhaganam	4	1.00	1.00
Nellikampatty	8	0.13	0.00
Edapalayam	4	0.25	3.50
Vallakadavu			
Aruvioda	38	1.74	0.13
Meenar	11.1	0.27	0.09
Kochupampa	4.5	0.00	0.00
Pandianthodu	3.1	0.00	0.00
Kakki	7.3	0.14	0.00
Vallakadavu	8	0.00	0.25
Kalaradichan	4	0.00	0.25
Kozhikanam	4	0.25	1.25
Thondiyar	5	0.40	0.00
Periyar			
Ummikuppan	8	0.00	0.50
Rendatinkara	4	0.00	0.50
Thannikudy	20	0.40	0.00
Mavadi	4	0.50	0.50
Sundaramala	8	0.13	0.00
Periyar	8	0.13	0.00
Mlappara	4.6	0.00	3.04
Eravangalar	4	1.50	0.25
Thamara	4	0.00	0.00
Kottamala	12.8	0.08	0.16
Moolavaiga	9.3	0.22	0.00
Manalar	12	0.83	0.25
Pamba			
Ponnamabalamedu	13.5	0.30	0.00
Pambamala	10.8	0.19	0.00
Sabarimala	5	1.00	0.00
Azhutha			
Moozhikal	4	0.25	1.75
Uppupara	6	0.00	0.50
Choozhy	10	0.00	0.00
Satram	4	0.00	0.00

Results & discussion

Hornbill numbers and detections

Fifty-two of the 59 blocks in PTR were sampled for hornbills. The forest staff walked a total of 265 km during the trail survey. Hornbills were recorded in 39 blocks in the trail survey, and 34 blocks in the line transect survey. The trail survey resulted in 82 hornbill detections (49 Great Hornbill, 33 Malabar Grey Hornbill), while the transect survey resulted in 59 hornbill detections (34 Great Hornbill, 25 Malabar Grey Hornbill).

Relative abundance of hornbills

The encounter rate of hornbills varied across forest sections (Table 1). The overall encounter rate of hornbills was 0.78 birds/km. The encounter rate of Great Hornbill (0.48 birds/km) was higher than Malabar Grey (0.29 birds/km). When zero detections were removed from the analysis, the Great Hornbill encounter rate still remained higher than for the Malabar Grey (Great- 0.62, Malabar Grey Hornbill 0.53). This is contrary to the findings of Mudappa & Raman (2009), where encounter rate of Malabar Grey was thrice as high as Great Hornbill. Kannan (1998) too encountered Malabar Grey Hornbills at a much higher rate (4.1/km) than Great Hornbills (0-2/km, n = 136 counts) in the Anaimalai Hills, farther northwards in the Western Ghats. Our encounter rate of Great Hornbill may be unusually higher than

that of Malabar Grey Hornbill because we had chance encounters of unusually large flocks of Great Hornbills in fig *Ficus* sp., trees. To eliminate such spikes, we removed all hornbill encounters with more than ten birds and recalculated the encounter rates—which provided a slightly higher encounter rate for Malabar Grey (Great—0.27, Malabar Grey—0.32).

Encounter rate of hornbills was highest in Edapalayam (3.75 birds/km) and Mlappara (3.04 birds/km). Great Hornbill encounter rate was high in Aruvioda (1.75 birds/km), while Malabar Grey Hornbill encounter rates were high in Edapalayam and Mlappara (3.5 birds/km, and 3.04 birds/km). Five sections did not record any hornbills during the trail survey (Kochupampa, Kakki, Thamara, Choozhy, and Satram). The reasons behind high encounter rates in certain sections are unclear but may have to do with the nomadic nature of hornbills, whose movements are mainly dictated by fruiting patterns of trees, especially the seasonal and asynchronous fruiting of *Ficus* (Kannan 1998; Kannan & James 1999; Kannan & James 2009). Repeat surveys that will look at habitats utilised and fruiting tree availability are needed, during different seasons, to ascertain why certain sections had more hornbill numbers than others.

Habitat use

Habitat refers to the three major forest types; Moist Deciduous, Semi Evergreen, and Evergreen. Figs 2 and 3 depict the distribution of hornbills in various habitat types. The highest numbers of detections were in Moist Deciduous- (34%) and Evergreen Forest (32%). Great Hornbill detections were more in Evergreen Forest (37%), whereas Malabar Grey Hornbill detections were more in Moist Deciduous Forest (45%). The number of Malabar Grey Hornbills was significantly higher than Great Hornbills in Moist Deciduous Forest (Mann Whitney U: 610, p (same median): 0.66). However, in Evergreen Forest, Great Hornbill numbers were significantly higher (Mann Whitney U: 294.5, p (same median): 6.73E-06).

Mudappa & Raman (2009) reported similar observations for the entire Western Ghats. In north-eastern India, Great Hornbill numbers were highest in unlogged forest, which was correlated with large tree density (Datta 1998). Similarly, in the Anamalais most of the nests of Great Hornbill were located in Wet Evergreen Forest (Mudappa & Kannan 1997; Amitha Bachan *et al.* 2011). The reasons for such habitat affiliations of hornbills, in PTR, have to be explored focussing on the abundance of large girth trees for nesting, and that of preferred fruiting trees.

Hornbill density

The overall hornbill density was 7.4 / sq. km. Great Hornbill density was 6.4 / sq. km, and Malabar Grey Hornbill density was 8.2 / sq. km (Table 2).

Table 2. Density estimation details for the two species of hornbills in PTR (based on 52.2-km transects sampled) and Half Normal Key and Cosine adjustment model.

Details	Great Hornbill	Malabar Grey Hornbill	Combined
Number of transects (in which the species was detected)	26	17	34
Detection probability, m	55.5	70.8	48.6
Effective strip width, m	77.3	88.8	77.9
Density (sq. km.)	6.4	8.2	7.4

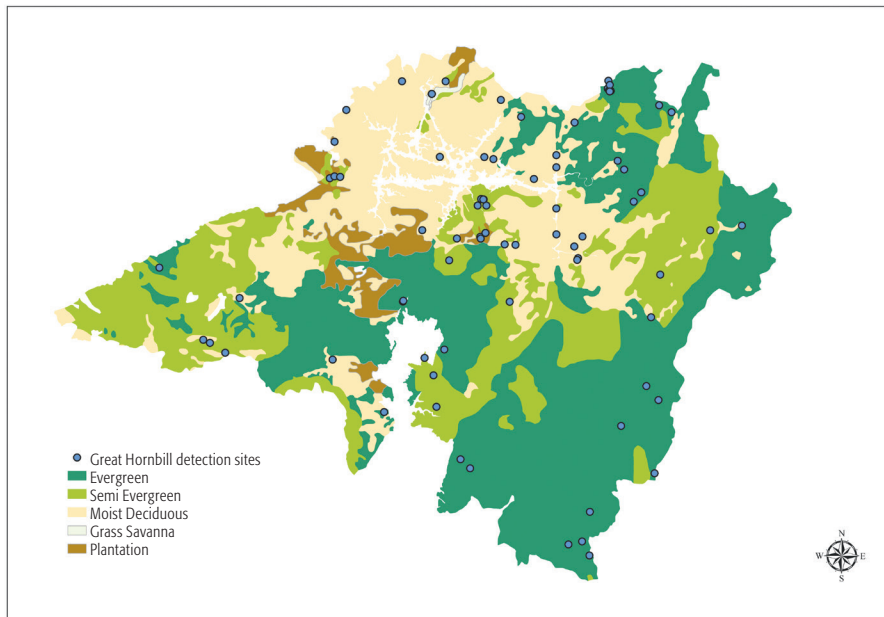


Fig. 2. Great Hornbill distribution across vegetation types

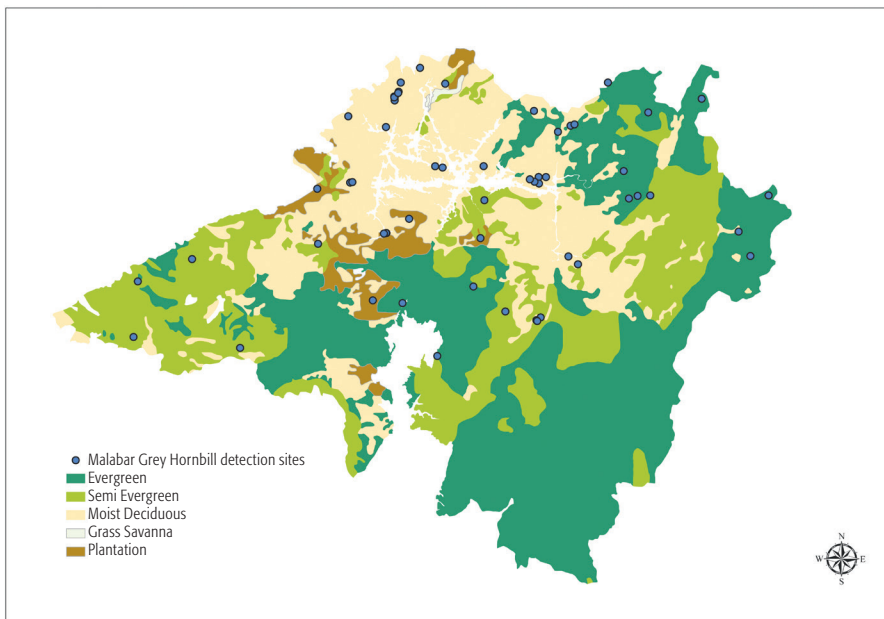


Fig. 3. Malabar Grey Hornbill distribution across vegetation types

Distribution

Hornbills were mostly recorded throughout PTR, with high concentrations around the Periyar Lake in Vallakadavu and Thekkady Forest Range. This observation is substantiated by more records in the 800–1300 m asl elevation range, which falls around the lake.

Hornbills were also distributed along most of the elevation gradients (Fig. 4). The highest number of hornbills was recorded between 800–1300 m asl. However, within this gradient there was a significant difference in hornbill numbers. Malabar Grey Hornbill numbers were significantly higher between 800–1000 m, while Great Hornbill numbers were significantly higher at elevations >1000 m (Table 3). The highest elevation at which

hornbills were detected was 1550 m in the Manalar section. However, elevations upto 1689 m were sampled.

Learnings, recommendations, and future programs

This exercise of using forest staff to estimate hornbill abundance in a protected area may have been the first of its kind in India. It has yielded useful insights into hornbill abundance, distribution, and habitat use, apart from lessons we learnt in the challenges in monitoring, and using the frontline staff. Utilising forest staff, during a period when they were less occupied in forest management activities, to monitor an easily recognisable taxa ensured the collection of better data from the area.

While a training programme for the forest staff—one week prior to the survey, explaining the methods and vision of the survey—is mandatory, ensuring that this training camp is presided over by all range officers, wildlife wardens, and park heads is important. Their presence ensures the much needed focus and interest among the ground staff who are otherwise not into biodiversity monitoring as their main job. Special care must be taken to spread the effort uniformly across all forest sections. Quick collection of the filled-in datasheet is needed to prevent losing the collected data.

Sharing the knowledge gained out of the survey with the forest staff is very important for motivating the forest staff to take up subsequent surveys.

We intend to continue monitoring hornbills in the park, using frontline forest staff, on a quarterly basis, to assess seasonal fluctuations and understand movement patterns. Additionally, we intend to design a monitoring scheme to identify the trees that hornbills forage upon, in the reserve, their abundance in each section, and their phenological patterns.

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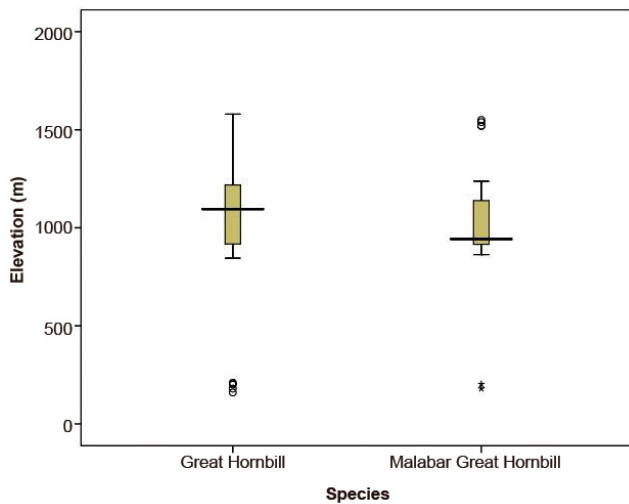


Fig. 4. Box plot depicting altitudinal distribution of hornbills.

Table 3. Hornbill numbers across elevation gradient

Elevation range	Great Hornbill	Malabar Grey Hornbill	Observed	Expected	Chi square value
150-300	8	7	15	7.5	0.06
300-500	0	0	0	0	-
500-800	0	0	0	0	-
800-1000	38	73*	111	55.5	11.03
1000-1300	95*	28	123	61.5	36.49
>1300	24*	5	29	14.5	12.44

Note: Hornbills were detected up to 1550 m
*significantly higher ($p < 0.05$)

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